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Seed Production Areas in the Lake States

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GUIDELINES FOR THEIR ESTABLISHMENT AND MANAGEMENT

by
Paul O. Rudolf

LAKE STATES FOREST EXPERIMENT STATION
M. B. Dickerman, Director
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

Foreword

Most public forestry agencies and some private agencies in the Lake States have accepted the need for forest tree seed that will produce high-quality trees. A first step in this direction is the establishment of seed production areas, but unfortunately research and experience to guide such work in this region is limited. Nevertheless there is urgent need to establish seed production areas without delay while suitable natural stands still are available and while large-scale planting programs are in effect.

It is recognized that the guidelines presented here for the establishment and management of seed production areas in the Lake States probably may not be the best possible ones, but they do present the best information now available. They are based largely on research and experience from other regions and involving other species. Although details may vary, however, the principles are considered of general application. Furthermore, it is intended that research will be carried on concomitantly with the establishment of seed production areas in this region. Its results will be put into application currently to improve seed production area management. In the meantime the present guidelines will help to get the work under way on a firm basis.

Cover picture: This is a 55-year-old, recently thinned red pine stand in northern Minnesota. It is in the young portion of the preferred age range for establishing seed production areas in red pine. Selection would have been more rigid and thinning heavier for seed production purposes.

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Seed Production Areas for the Lake States: Guidelines for their establishment and management

By Paul O. Rudolf[1/]

Reforestation is needed on 8 million acres or more in the Lake States (Minnesota, Wisconsin, and Michigan) according to the best estimates available. This area should be planted with the best adapted and most productive planting stock we can grow. The stock should be produced from seed with the best genetic potential available.

At present the search is under way for forest trees outstanding in volume production, wood quality, form, growth habit, and resistance to injury. These trees will be propagated vegetatively and tested for genetic superiority. Those that give high-quality progeny will be used to develop seed orchards for the abundant production and easy collection of superior seed.

It probably will be at least 40 years until enough seed orchards[2/] are available in the Lake States to produce most of the forest tree seed needed. It will be even longer before the best clones have been found and tested adequately for this purpose. In the meantime a valuable intermediate step can be taken by developing seed production areas.[2/] For

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1/ Research forester, Lake States Forest Experiment Station. The Station is maintained at St. Paul 1, Minn., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of Minnesota.

2/ The terms "seed orchard" and "seed production area" have sometimes been used loosely and interchangeably. As used in this paper they are defined as follows: (1) A seed orchard is a plantation consisting of clones or progeny from selected trees isolated to prevent pollination from outside sources, and cultured for early and abundant seed production; (2) a seed production area is a superior (plus) stand which is upgraded by periodic removal of undesirable trees (roguing) and cultured for early and abundant seed production. The latter usually were originally established for purposes other than seed production and are usually less intensively selected, isolated, tested, and cultured than seed orchards.

that purpose the best stands of important forest tree species should be located and so treated that abundant seed will be produced on the best trees. Rather small areas will be sufficient to supply the seed needs of the region, and collection should be concentrated in these areas as soon as they are developed.

Little or no local experience is available as a guide in the establishment of seed production areas in the Lake States. However, there is some knowledge concerning the seeding habits of our important forest tree species, and work has been done on seed production areas in other regions and countries. Based on that knowledge and experience, some guidelines for the Lake States have been prepared. As local experience and research develop, these guidelines can be improved.

Past experience

Although some experience in this direction has been accumulated in Sweden and other parts of Europe, most of the related effort there now concerns the establishment of seed orchards.

Probably the most extensive experience with seed production areas in the United States is that of the West Virginia Pulp and Paper Company. Essentially their procedure has been as follows: (1) Loblolly pine and slash pine plus-stands, 5 to 6 acres in extent, are selected and marked for cutting so as to leave 15 to 25 of the best individuals per acre; (2) the other trees in the stand are cut and sold for merchantable products; (3) after logging, all hardwoods over 5 to 6 feet tall are removed or sprayed with chemical herbicides; (4) 4 years later all but 4 per acre of the selected trees are felled, the cones collected, and then the trees are converted to wood products (4 trees per acre are left to reseed the area, after which they too are cut when the cone crop can be harvested); (5) in some younger stands (10 to 30 years) plus-trees have been selected, released, and sometimes treated (by steel bands or by topping) to stimulate seed production (Easley 1953, 1955).

Cone yields have run from 1 to 1-2/3 bushels per tree, and the company is well pleased with the quality of the seed and the resulting nursery stock as well as the modest cost of the program--the cleaned seed costs have run from $2.39 to $2.85 per pound (Easley 1955).

Experience somewhat more comparable in procedures to those considered for the Lake States has been reported from Texas (Goddard 1958). There cones were collected by climbing mature, standing loblolly pine trees, and repeated collections from the same stand are anticipated. Costs in a good seed-crop year averaged $4.77 per bushel of cones or $3.14 per pound of unextracted seed, about 61 percent of the costs for collecting in a light crop year. Collection was easier and more productive from narrow-crowned

than from wide-crowned trees. Similar information for slash pine and loblolly pine seed production areas in Florida indicated a yield of more than 1/2 bushel of cones per tree, a collection cost of about $8 per bushel by climbing, and a severalfold increase in cone production from release of the seed trees.3/

Closer to home, the Wisconsin Conservation Department has begun the establishment of seed production areas (Hitt 1958). First-year experience involved unmanaged red pine stands 40 to 75 years old and trees mostly 60 to 75 feet tall. With experienced collectors (with some climbing experience) cones were obtained at an average cost of $9.12 per bushel in a good seed year. With inexperienced collectors (and climbers) costs were more than doubled. An average of about 1/4 bushel of cones per tree was harvested. Earlier studies indicated that it took from 2 to 6 man-hours for experienced collectors to gather a bushel of cones.4/ The differences in time reflected climbing difficulties (whether or not ladders were needed), size of cone crop, and size of cone-producing crowns.

These experiences indicate that the cost of cones from seed production areas will be higher than that from open-market cone purchases by about 50 to 100 percent. This will increase seed costs by about that amount, although better yields may partially offset the increase. However, since seed procurement accounts for only a small part of the total nursery stock production costs, the increased seed costs will not add much to the total and should be more than offset by the better quality of the stock obtained.

Establishing the areas

On each national forest, state forest, industrial forest, and comparable area in the Lake States the best stands of the species should be selected for use in reforestation. Planted stands may be included if they are of sufficient age and of known desirable seed origin. Presently such selection should include the following five species: Red pine, jack pine, white pine, white spruce, and black spruce. As other species are included in the reforestation program, they should be added. Sufficient area of the best stands or trees should be selected to provide enough seed to meet the needs of national forest, state forest, industrial forest, and local adjacent areas. These stands should then be treated so as to favor the best trees and to stimulate their seed production. The

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3/ Unpublished information supplied Chi-wu Wang of the University of Florida by Walter Beers of the Buckeye Cellulose Corporation of Foley, Fla.

4/ Hitt, Robert G. "Annual Report, 1955-56, Project #768," University of Wisconsin. Dittoed.

A good 60- to 70-year-old white pine stand in Northeastern Minnesota. It had been liberated and pruned 10 years earlier. It is at the medium to upper age preferred for establishing seed production areas. For that purpose, only 30 to 40 of the best trees per acre would be retained, and the competing brush would be controlled.

stands should, of course, be protected against damage from fire, insects, diseases, and animals. If a forest includes more than one seed collection zone (Rudolf 1957), efforts should be made to locate seed production areas in each zone.

Choosing the Stands

Stands for seed production areas should be of medium age and should contain trees of good vigor, soundness, form, fecundity, branch thickness, and branch habit. For further details on specifications, consult the "Guide for Selecting Superior Forest Trees and Stands in the Lake States" (Rudolf 1956). Young stands should be avoided, principally because they

cannot give adequate indication of their potential development and because of low seed production. Old stands, on the other hand, will not respond so well to treatment and will be in production only a relatively short time.

The stands should be even-aged and should not have been thinned previously, unless records are available to show that thinning was from below.

It is suggested that the minimum age for selection be the time commercial seed production begins and the maximum age be about one-half of rotation age. In unusual circumstances older stands may have to be used, but they should not exceed three-fourths of rotation age. For the five major species these ages are shown in the tabulation below.

Species	Establish seed production areas between these ages (years)	
	Minimum	Preferred range
Red pine	30	50 - 70
Jack pine	20	30 - 40
White pine	25	50 - 70
White spruce	30	45 - 60
Black spruce	30	45 - 60

Seed production may be relatively low in young stands. At the beginning of the program, supplemental collections may have to be made in good stands outside the seed production areas.

Stand Treatment

In each selected stand three steps should be undertaken immediately:

1. Choose the best trees in the stand on the basis of vigor, form, crown and branching habit, and seed production. The number of seed-crop trees per acre will vary by species, age, and site quality from about 30 to 170 at the time of establishment (see table 1). At maturity the number will be smaller.

2. Rogue out all undesirable trees (below average in vigor, poor form, diseased or damaged, spiral grained, heavy branched, etc.).

3. Give the selected seed-crop trees extra growing space by removal of competing trees. It is suggested that the average spacing between crop trees be about one-half the average height of the dominants and codominants. Additional cuts should be made at

Table 1.--Guide to average spacing and number of trees per acre to leave on seed production areas

Species	Age	Average spacing between trees 1/	Average trees per acre
	Years	Feet	Number
Red pine	50	28	56
	70	35	36
	120	46	21
White pine	50	30	48
	70	40	27
	120	53	16
Jack pine	30	16	170
	40	22	89
	60	28	56
White spruce	45	24	76
	60	32	43
	120	43	24
Black spruce	45	18	135
	60	23	83
	120	32	43

1/ Equal to one-half the average height of dominant and co-dominant trees on medium sites; on poor sites heights will be lower and more trees will be required, while on good sites the reverse will be true.

A good 50-year-old black spruce stand in northern Minnesota. It is at the upper preferred age for establishing seed production areas. For that purpose about 85 of the very best trees per acre would be left in the stand.

about 10-year intervals, each time favoring the best trees.[5/] Where choices are equal, spacing considerations should govern. Felling should be done carefully so as to avoid damage to the crowns of the selected trees. Cutting down to the final number of crop trees should not be done prematurely. A small reserve of potential seed-crop trees should be carried to fill in for losses from lightning, wind breakage, or other injurious agencies.

Any concentrations of brush or competing hardwoods should be controlled by chemical herbicides both to give the selected trees full access to soil moisture and mineral nutrients and to facilitate cone picking and protection activities.

5/ So far as possible such cuts should be made in years with 50-percent or better cone crops and when the cones have ripened, so that an additional supply of seed can be obtained at reduced cost.

Isolation Zones

Each seed production stand should be protected from pollination by less desirable trees of the same species. If it is part of a larger stand the seed production area should be surrounded by a zone in which only trees of the same caliber as the seed-crop trees are allowed to remain, or in which there have been removed all trees of the selected species or others that may cross pollinate naturally.

The width of the zone cannot be set precisely, but studies in other regions have shown that tree pollen may be dispersed long distances. The amount dispersed for several conifers, however, falls off sharply beyond 300 to 400 feet from the seed tree (Wright 1952). It is suggested, therefore, that the isolation zone be at least 400 feet wide (Georgia Crop Improvement Association 1958).

Area or Trees Needed

The number of seed-crop trees needed will depend on the production per tree and the amount of planting stock needed. The latter is subject to some fluctuation. Suggestions here are put on the basis of the seed trees needed per 1,000,000 plantable seedlings.

Local data concerning seed production on trees given special treatment are not generally available. Records from northern Minnesota, however, have shown that seed production for managed red pine stands was nearly double that for comparable unmanaged stands in a good seed year.6/ Results with loblolly pine in the southeastern Coastal Plain and in Texas also have shown distinctly increased seed production following release of the seed trees (McCulley 1953, Goddard 1958). The former indicated consistently good seed production on the released area which ran 1.5 to 11 times that of comparable unreleased stands in the same years.

Despite lack of precise data on treatment effects we can calculate the number of seed trees needed to produce an average of 1,000,000 plantable seedlings per year on the basis of our knowledge of average seed yield per tree, frequency of average or better cone crops, laboratory germination of the seed, and tree percent (U. S. Forest Serv. 1948, Stoeckeler and Jones 1957).6/ Assuming that collections will be made only in those years that 50 percent or more of a full cone crop is produced, the number of seed-crop trees required per million seedlings will vary from about 210 to 910 (table 2). Translated into acres of stand this will range from about 4 to 30 per species. These values are very small. Because of variability in seed production and the proportion of the crop that can be harvested from standing trees, a safety factor of 2 has been

6/ Unpublished data on file at the Lake States Forest Experiment Station.

Table 2.--Calculation of seed trees required to produce an average of 1,000,000 plantable seedlings per year

Species	Clean seed: Per bushel cones	Clean seed: Per pound	Average cone production per 1/ seed tree	Laboratory germination of seed	Tree percent	Average usable seedlings per tree	Average interval between crops 50% or better	Needed per million seedlings per year 2/: Seed trees	Needed per million seedlings per year 2/: Area
	Lbs.	No.	Bu.	Pct.	Pct.	No.	Yrs.	No.	Acres
Red pine	0.46	52,000	0.25	85	65	3,300	3	600	30
White pine	.95	27,000	.76	65	65	8,200	2	240	16
Jack pine	.52	131,000	.44	65	50	9,700	1½	210	4
White spruce	.45	240,000	.48	50	35	9,100	2	220	10
Black spruce	.25	404,000	.11	50	40	2,200	1½	910	22

1/ Based on good seed-year production of 1 bushel of cones for red pine and jack pine, 1½ bushels for white spruce, 2 bushels for white pine, ¼ bushel for black spruce, and reduced amounts in off years for all species. The average production listed is based on 13 years of seed-crop reports for the Lake States and includes only those years for which a crop of 50 percent or better was produced.

2/ A safety factor of 2 is included.

This is a good, thinned, 40-year-old jack pine stand in northern Minnesota. It is in the upper preferred age for establishing seed production areas. Only about one-third of the best trees shown would be retained if this were a seed production area.

used. Increased seed production resulting from release and other treatments provide an additional safety factor. It is recommended further that each forest or comparable unit have two or more separate seed production areas per species to avoid complete loss in the event of catastrophes.

Seed production areas should be so located as to provide seed for each geographic race or ecotype of a species represented in a given forest or planting area. Where such information is lacking, recognized seed collection zones should be represented (Rudolf 1957). This will help provide planting stock both well adapted to the locality and of good genetic quality.

Maintaining the areas

The seed-crop trees must be protected from damaging agents and given good growing conditions. It may be desirable also to provide treatments that will stimulate seed production. The boundaries of each seed production area should be marked clearly and in distinctive fashion.

Protection

The seed production areas should be fully protected from fire, especially

crown fires. If a cleared isolation zone is provided, it will give good protection against crown fires. Fire lanes surrounding each area probably would be desirable. Furthermore, each seed production area should be highly accessible so that prompt fire control efforts will be possible.

The seed production trees should, of course, be protected from insect and disease damage as far as possible. This is true not only of those pests that reduce tree vigor but also of those that injure mainly the flowers and cones. Frequent (at least annual) checks should be made for the presence of insect enemies and diseases. Whenever any evidences of damage are found the forest entomologists and forest pathologists should be consulted immediately and recommended control practices applied without delay.

Squirrels, and sometimes other animals, may cut flowering or cone-bearing twigs and thus reduce not only the current seed crop but also possible future crops. Such pests should also be controlled. In Texas squirrel damage has been held in check through the use of metal bands, 18 inches wide, placed around the trunks of the seed trees (Goddard 1958).

Unauthorized cone collection from the seed production areas should be prevented. Prominent marking of boundaries and the use of signs may help in this regard. Patrolling a few weeks in advance of the collecting season may be advisable.

The trees should also be protected from unnecessary injury during seed harvest. This may be accomplished by training the cone pickers to be careful of the trees and by using ladders as much as possible during picking. Pickers should wear gloves and use wire hooks to pull in the cone-bearing branches. They should not be allowed to cut off cone-bearing twigs. In some localities it may be possible to contract cone picking to tree surgery companies that have experienced climbers, and thus prevent injury by and to untrained climbers. The use of truck-mounted ladders in some instances may be economical and prevent some damage to the tree trunk from frequent climbing.

The climbers and their supervisors should be familiar with and apply the recommendations in such guides as "Health and Safety Code" (U. S. Department of Agriculture 1958), "Safety Tips for Northwest Tree Breeders" (Greathouse and Blaser 1958), and "Climbing Southern Pines Safely" (Snyder and Rossoll 1958).

Reducing Competition

Hardwood species or shrubs that offer serious competition for soil moisture and nutrients should be controlled by chemical herbicides or mechanical means. The latter can be done by disking the area between the seed-crop trees, but it will have to be done carefully, so that neither the roots nor the stems of the crop trees are injured. Mowing followed by

herbicides to control resprouting brush is another possible method. Removal of competing growth will have the added advantage of making the trees more accessible during collection.

Stimulating Seed Production

In addition to providing abundant growing space and reduced competition it may be desirable to utilize other means to stimulate seed production. This may include employing mineral fertilizers, cultivation of the soil, topping of the trees, stem constriction by metal bands, and possibly other practices (Arnborg 1956, Mathews and McLean 1957). All these methods will have to await research results before meaningful prescriptions can be provided.

Research needed

Because the use of seed production areas is a new venture in the Lake States, research is needed on nearly all phases of their establishment and management. The fact that seed production areas may be in use only a few decades is relatively unimportant because most of the studies will also be applicable to seed orchard management.

Some of the questions that need answering and on which research would be helpful in managing seed production areas of the various species are the following:

1. The effects of various fertilizers and combinations of fertilizers on seed production of the species concerned on various soils.

2. The relationship between tree diameter, crown volume, or vigor classes to amount of cone production.

3. How stem pruning and top pruning affect seed production.

4. The effects of various hormones and related substances on seed production.

5. What various ground treatments (clean cultivation, chemical control of woody competitors, cover crops, or hay crops) do to seed production.

6. The effects of strangulation, girdling, root-pruning, and other injurious treatments on seed production.

7. Whether irrigation improves seed-crop production.

8. Influence of various methods of annual cone harvesting on continued seed production.

9. How to reduce flower and seed losses to pests.

10. Pollen barrier requirements.

To a large extent these studies can be conducted on various seed production areas as they become established.

Research findings on any of these problems will help to improve the handling both of seed production areas and seed orchards. Studies on some of these problems are already under way in the Lake States. More such research is needed.

Summary of recommendations

I. Select stands with -

A. Trees of good vigor, soundness, form, seed production, and branch habit.

B. Ages as follows:

	Minimum	Preferred range
Red pine	30	50-70
Jack pine	20	30-40
White pine	25	50-70
White spruce	30	45-60
Black spruce	30	45-60

II. Treat selected stands as follows:

A. Choose 30-170 of best trees per acre as seed-crop trees (see table 1).

B. Rogue out all undesirable trees (poor form, diseased or damaged, heavy branched, spiral grain, etc.).

C. Remove competing trees of same species in series of cuts at about 10-year intervals. Leave the trees at an average spacing equal to one-half the average height of dominant and codominant trees.

D. Control concentrations of brush or competing hardwoods with chemical herbicides or by mechanical means and subsequent spraying.

E. Provide 400-foot isolation zone either (1) free of all species of trees that will cross pollinate naturally with selected trees, or (2) treated same as seed production area.

F. Collect cones by climbing trees each year there is 50 percent or more of a full crop.

III. To produce an average of 1,000,000 plantable seedlings per year in the nursery, provide at least the following number of seed production trees:

Red pine	600	White spruce	220
White pine	240	Black spruce	910
Jack pine	210		

These numbers include a safety factor of 2.

IV. Protect the seed production trees from fire, insects, disease, animals (squirrels, etc.), and injury during cone harvest.

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